The Littoral Combat Ship

From Concept to Program

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Introduction

After the end of the Cold War, the United States faced a sharply diminished threat in the ocean commons. The Soviet Union broke up and its navy was taken over by the Russian Federation, which scaled back sharply on its shipbuilding and operational deployment. The U.S. Navy soon found itself without a global competitor.

The Navy moved to refocus itself to meet the post-Cold War environment in September 1992, when the Secretary of the Navy, the Chief of Naval Operations, and the Commandant of the Marine Corps signed …*From the Sea*. This white paper outlined a "fundamental shift away from open-ocean warfighting on the sea toward joint operations conducted *from the sea*."[1] It was followed in November 1994 by *Forward…From the Sea*, another Navy-Marine Corps paper that refined …*From the Sea* and elaborated on the importance of peacetime forward presence operations. While retaining its ability to maintain strategic dominance in the ocean commons, the Navy was adopting a new, interventionist outlook that focused strongly on what was taking place on shore.

This focus on influencing operations ashore drew the Navy into the littoral.[2] Naval strategists noted that the littoral is where the great bulk of the world's population lives, where much of its wealth is generated, and where lines of communication for ocean-borne cargo begin and end. Moreover, it is the area through which an expeditionary military force must pass and in which supporting Naval forces must operate.

Operating in the littoral presents a complex collection of challenges. As …*From the Sea* put it, the "mastery of the littoral should not be presumed." …*From the Sea* recognized that "Some littoral threats–specifically mines, sea-skimming cruise missiles, and tactical ballistic missiles–tax the capabilities of our current systems and force structure." In the past decade, swarming small boats (armed with short range missiles or a payload of explosives) and diesel submarines have also been cited by the Navy as obstructing U.S. access to the littoral. These systems enable even relatively unsophisticated adversaries to adopt a strategy of anti-access and area denial (A2/AD), whereby the defender seeks to prevent the attacker from bringing strike power to bear with a layered, but not symmetric force-on-force, defense of the approaches.

New, Small Ships for a New Era

Faced with A2/AD challenges, Navy strategy initially focused on avoiding operating in the littoral and, instead, on projecting power *over* the littorals using air power, missiles, and gunfire, delivered by aircraft, surface combatants, and missile-launching submarines already in the fleet. Exposure to mines and anti-ship cruise missiles would be minimized

[1] "From the Sea: Preparing the Naval Service for the 21st Century," 1992. Available online at <http://www.chinfo.navy.mil/navpalib/policy/fromsea/fromsea.txt>. Accessed on August 9, 2006. Emphasis added through italics.

[2] The littoral can be demarcated in several ways, but a useful way to think about it is as that stretch of shore from which events on the water can be influenced and that swath of ocean from which events on shore can be influenced.

by using long-range weapons and standing off from the shore as far as possible. This operational focus was embodied in the DD-21 Land Attack Destroyer program, which, in the late 1990s, was the centerpiece of the Navy's surface combatant procurement plans. The proposed ship, of which Navy initially was to build 32, was tailored for projecting power on land. Its primary mission would be to support ground forces. Gradually, however, elements within the Navy began to conceive of the need to operate *in* the littorals, and operate there persistently, rather than relying on standoff munitions and occasional sorties through the littoral to support the land battle. These elements saw the shortcomings of the current systems and force structure alluded to by …*From the Sea* and proposed a way to fill the gap with new, small surface combatants.

The evolution towards a new class of ships for littoral operations began gradually. Though the Navy had had small ships in the fleet for many years (including such platforms as the *Asheville* class of patrol gunboats, the *Pegasus* class of hydrofoil missile boats, and the *Cyclone* class of coastal patrol craft), they had never been well integrated into the fleet and had seldom been used effectively. There were advocates for an expanded small ship role in the battle force, notably then-CAPT Wayne Hughes, a professor at the Naval Postgraduate School, who wrote an influential book on fleet tactics in 1986.[3] Hughes argued that fleet combat would favor whichever side could preserve its combat power for the longest period during an exchange of missile salvos, and that the survivability of combat power could be achieved through distributing it from several large missile-carrying ships to a dispersed fleet of smaller missile-armed ships. These small missile ships could sortie out from a mothership, much as aircraft do from an aircraft carrier. The arguments of Hughes and others who favored this approach did not readily find traction, however.

Another impetus to small ships was programmatic. As a 1997 GAO report indicated, the Navy's shipbuilding program faced a significant fiscal challenge. The unit cost of the ships the Navy had designed to replace its aging fleet was up sharply. If it were to meet its stated force structure goal of 346 ships (later increased to 375), the Navy would have to either spend more or buy less expensive ships. The GAO did not explicitly suggest a small ship, and it did not focus on the A2/AD and the littoral, but it did point out that adding increased capability (such as the Aegis radar system) to multimission ships was the main driver of increased unit costs. To meet its force structure goals, the GAO suggested that the Navy might consider cheaper (if not necessarily smaller), "tailored capability" ships that would perform only one or two missions, like anti-submarine warfare (ASW) or anti-aircraft defense (AAD).

The strategic need to gain access and operate in and around the littorals was taken up by the Chief of Naval Operations' Strategic Studies Group (SSG) housed at the Naval War College. The SSG is a group of naval officers that undertakes special studies for the CNO on innovative naval warfare concepts. From 1998 to 2000, the SSG focused on how the Navy should operate in and dominate the littoral. Though the SSG did not make a specific proposal for a new type of small combatant, it argued for two attributes for the

[3] Wayne P. Hughes, Jr., *Fleet Tactics: Theory and Practice* (Annapolis, MD: Naval Institute Press, 1986). This book was updated for coastal operations in 2000.

future fleet and its platforms that became central to the small ship debate: distributed combat power, to include a greater number of networked combat ships, the use of unmanned vehicles (UVs) and offboard sensors, and modularity to provide mission flexibility.

The SSG concluded that combat power in the current Navy was tied to particular hulls. The battle force ships were capable of carrying out a variety of missions. For example, the Navy's main destroyer type, the DDG-51 *Arleigh Burke* class had the capacity to conduct ASW, fleet air defense, land attack, mine warfare (MIW), and other missions. All this combat power would be lost if the fleet lost that one ship. The SSG argued that distributing this combat power on UVs, such as unmanned aerial vehicles (UAVs) to deliver strikes ashore and unmanned undersea vehicles (UUVs) to hunt for mines and submarines, would make the fleet's combat power more survivable. In this, the SSG echoed Hughes's analysis. Further, distributed, unmanned sensors would allow the fleet to develop more robust battlespace knowledge than would sensors limited to the area around a single hull. Battlespace knowledge and the network needed to exploit this knowledge were seen by the SSG to be essential to dominating the complex littoral environment.

Modularity was also important to the SSG's thinking on littoral challenges. Modularity—the ability to tailor a platform's capabilities on a mission-by-mission basis—provided valuable and affordable flexibility. A fleet that distributed its combat power using UVs was inherently modular; ships could embark the necessary UVs for the mission at hand.[4] A further level of modularity was also available: the UVs themselves could be configured to carry different sensor and weapons packages. Modularity also made it easier to upgrade platforms when new technologies became available.

As the SSG developed analyses on littoral challenges, a parallel effort to address the Navy's role in the littorals was underway at the Naval War College, led by its President, VADM Arthur Cebrowski. VADM Cebrowski was concerned that the Navy was not keeping itself relevant to the emerging threat environment. If the Naval services were going to project power "forward from the sea," they would have to be capable of maintaining a persistent presence in the littoral, not just sortieing into or overflying it to launch missiles or deliver troops. This was something that neither the existing nor the programmed fleet was well suited to do.

Cebrowski and Hughes co-authored a widely discussed article in the fall of 1999 in the U.S. Naval Institute journal *Proceedings*[5] that further developed the concept of distributed power and linked it specifically to a new class of ship. The principal problem, as the authors saw it, was that the fleet was "tactically unstable." An increasing portion of the Navy's combat power was vested in a diminishing number of hulls, and the combat power of these ships was growing out of proportion to their survivability. The Navy had cause to be concerned about its ability to operate in high-risk littoral environments.

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[4] *Naval Power Forward*, Report of the Chief of Naval Operations Strategic Studies Group XIX, September 2000, 4-1.

[5] Arthur K. Cebrowski and Wayne P. Hughes, Jr., "Rebalancing the Fleet," *Proceedings*, November 1999.

Adversaries could employ relatively affordable measures—submarines and mines, of course—but Cebrowski and Hughes were especially concerned about small boats armed with anti-ship missiles that could attack U.S. surface combatants in coastal areas. U.S. surface combatants, meanwhile, were increasing in expense and capability and decreasing in number. As the loss of a ship became an ever-costlier prospect, both in dollars and in combat power, Cebrowski and Hughes warned, the Navy was in danger of becoming risk averse, or self-deterring, and putting itself at a significant operational disadvantage in littoral operations.

The solution to this emerging problem, Cebrowski and Hughes proposed, was a two-tiered fleet made of an Economy A force and an Economy B force. The Economy A force, composed of CVNs, DDG-51s, CG-47s, and later DD-21s, would provide the power projection capability and dominate the broad ocean commons. The Economy B force, composed of a family of smaller, less expensive ships, would counter access denial threats in the littorals. Distributing combat power among more platforms would make the fleet more tactically stable and lessen the need to expose Economy A ships, and the large amount of combat power they contain, to littoral dangers. More hulls would also provide a greater ability to sense in a cluttered littoral environment thereby developing greater battlespace awareness.

The Economy B force proposed in the article was based on a concept called *Streetfighter*.[6] *Streetfighter*, developed and espoused by Cebrowski, assumed a central position in the debate on the Navy's need for a new class of small ships. The *Streetfighter* concept called for a family of small ships that would be fast, networked, and modular and would make extensive use of unmanned vehicles. They would also be austerely manned and cheap enough to afford in large numbers. Cebrowski and others pointed to technological advances in the commercial sector, especially in ship speed, sea-keeping, and payload fraction, as enabling factors for a new class of small warships.

Expendability was one of the foundations of the *Streetfighter* concept: the Navy could put these ships at risk since, if one were lost, the Navy lost only a small fraction of the aggregate combat power inherent in the distributed Economy B fleet. In their article on rebalancing the fleet, Cebrowski and Hughes called for the *Streetfighter*/Economy B force to "cost less than 10% as much as Economy A, comprise more than 25% of total numbers, and be expected to suffer most of the combat losses in littoral warfare."[7] This line of thinking was controversial. Many in the Navy were unhappy with the idea of a "ship designed to lose."

Besides restoring tactical stability to the fleet and improving the Navy's ability to assure access, advocates attributed various other benefits to a new class of small ships. Among them:

[6] The term *Streetfighter* was coined by ADM Don Pilling, then VCNO, in a speech to the American Shipbuilding Association in 1999.
[7] Cebrowski and Hughes, 32.

- Small ships would relieve highly capable multimission ships of the need to perform such tasks as maritime interdiction operations (MIO) that made poor use of their considerable potential combat power and stretched the current fleet thin.

- Small ships would rejuvenate the maritime industrial base by allowing shipyards that could not produce large surface combatants to compete for contracts. Only a few naval shipbuilding yards were capable of building large surface combatants, creating mutual dependency between the industry and the Navy—the yards needed consistent work to maintain their infrastructure, and the Navy needed the yards to survive to guarantee a future source of ships. More, smaller ships, it was hoped, would create a more competitive industry, stimulating innovation and lowering costs.

- A fleet composed in part of smaller, less expensive ships, would scale better than the then-programmed fleet. With the then-programmed fleet, if the Navy needed to cut money from the procurement budget it had few options but to cut one of the very few multi-billion dollar ships it funded each year, and thus had to chose between cutting a big chunk of combat power or cutting nothing at all. By the same token, it took a large amount of additional funding to scale up procurement by even one ship. Smaller, less expensive ships could be added or subtracted without causing such turbulence in the shipbuilding program.

Variations on the *Streetfighter* concept emerged between 1999 and 2000, all firmly rooted in a class of ships that were numerous, small, fast, networked, and modular. The three main variations can be broadly described as follows: distributed offense, distributed defense, and delivery of off-board weapons and sensors.[8]

The distributed defense model had small, fast ships acting as screens for the main battle force in the littoral. This was the model that was tested when the *Streetfighter* concept received its first major exposure, in the Naval War College Global 1999 wargame. The annual Global game has typically been a key vehicle for the Naval leadership to explore and assess innovations in force structure and operational concepts. Cebrowski directed that two different types of small combatants be inserted into the game. These were a ship with a 160-ton payload capacity that carried either an ASW or MIW module, and a ship with a 400-ton modular payload that served primarily as a missile magazine.[9] Participants made effective use of the small ships as front-line combatants. A key finding was that the Red force submarines and surface combatants were reluctant to expose themselves for the sake of firing on a small ship, and so the small ships were able to operate with a surprising degree of survivability.

The distributed offense model was conceived of as a flotilla of very small ships supported by a mothership. Such a concept was described by Hughes, both in his early writings and

[8] This typology is described in Robert Work's thorough examination of the LCS program and its antecedents, *Naval Transformation and the Littoral Combat Ship* (Washington, DC: Center for Strategic and Budgetary Analysis, 2004) 61.
[9] Ibid., 61.

in an article in the February 2000 issue of *Proceedings*.[10] Hughes's notional ships were modular, displaced ~300 tons, and could be outfitted both to deal with littoral threats like mines and to launch land attack missiles. The mothership was one possible solution to the challenges that the so-called "iron triangle" of naval architecture imposed—the trade-offs between speed, payload, and endurance inevitable in any ship design. By using a mothership, small ships could be fast and have a useful payload because they would not need to self-deploy across large distances or sustain themselves for long periods of time on station.

The most fully developed *Streetfighter*-type design focused on the delivery of off-board weapons and sensors. It came from a design exercise called Sea Lance. Sea Lance arose out of a 2000 Naval Warfare Development Center (NWDC) and Defense Advanced Research Projects Agency (DARPA) study called Capabilities for the Navy After Next (CNAN). CNAN addressed the importance of achieving access in the littorals. Part of the CNAN solution to the problem was an Expeditionary Warfare Grid. This grid is a net of unattended sensors (like radar buoys and sonar buoys) and unattended weapons (like floating torpedoes and cruise missiles) laid in coastal waters. In mid-2000, Cebrowski challenged students at the Naval Postgraduate School to design a system that would be able to implement the CNAN grid concept. The NPG team proposed a team of two ships: a small combatant and a mule, a ship towed behind the combatant that would carry the elements of the Expeditionary Warfare Grid. While the grid and the mule were unique among *Streetfighter*-type proposals, the Sea Lance combatant (as designed) stuck closely to important *Streetfighter* principles. It was small: less than 500 tons full load displacement. It was designed to implement network centric warfare. It made significant use of off-board systems, and so had inherently modular capability. It was also expendable: its low cost (less than $100M for the first ship), austere manning (a crew of 13), and numbers (there would be squadrons of 10 ships with their mules) meant that it could be risked in the hazardous littoral environment.

These three *Streetfighter*-type concepts were employed in the Global 2000 wargame.[11] Here, the concepts began to blend together.[12] The core elements were the same to start with: the ships were small, fast, networked, and modular. Developers added to this the most attractive attributes of the three ships and dropped out others. The Sea Lance's emphasis on offboard capability (a feature also emphasized earlier by the SSG) became a signal feature of the *Streetfighter* concept, which included both manned and unmanned offboard systems. The very smallest of the *Streetfighter*-type designs dropped off the table, as did the idea of using a mothership; developers focused on ships capable of self-deploying.

This conceptual work was supplemented by some naval architectural design and experimentation. NWDC experimented with a borrowed Australian fast catamaran in

[10] Wayne P. Hughes, Jr., "22 Questions for *Streetfighter*," *Proceedings*, February 2000.
[11] The Global 2000 wargame also included two other small ship designs: a modular, fast transport and a small aviation ship.
[12] Work, 62.

2000,[13] and later partnered with ONR, Navy Special Warfare Command, the Army, and the Marine Corps to lease such a ship in 2001. The ship, dubbed the High Speed Vessel (HSV), was used in part to experiment with small ship concepts. Though it was not a combatant, it was fast, shallow draft, and spacious, and thus could act as a stand-in for a *Streetfighter*-type vessel as well as demonstrate the value of having a fast connector for a future sea base. In addition, the Office of Naval Research developed a Littoral Support Craft-Experimental (LSC-X). Its keel was laid in 2003 and it was delivered in 2005. The ship, an aluminum catamaran that displaces 950 tons, is designed to accommodate modular payloads, can travel at speeds of up to 50 knots, and can deploy 2 helicopters. The program was designed to demonstrate the benefits of having a small craft for littoral operations. The Navy took delivery of the LSC-X (renamed FSF-1 *Sea Fighter*) in 2005.

While the design characteristics of a specific *Streetfighter* ship remained relatively indistinct, this did not prevent criticism of its attributes. With trade-offs necessary between speed, payload, and endurance, some questioned the premium *Streetfighter* placed on speed. Was a top speed of 50+ knots worth the reduced payload and endurance? If so, what analysis supported that conclusion? Others questioned whether current technology permitted the high payload fractions that Cebrowski suggested were possible.

Accepting a Small Ship

While NWDC and others continued to develop the *Streetfighter* concept, the Navy began to pay serious attention to the idea of developing a new small ship. Though by no means all in the Navy welcomed a new small combatant, there was broad agreement that assuring access to the littorals was important, that the Navy was not well prepared to deal with some important littoral threats (like submarines, mines, and small boats), and that the projected force structure was not adequate to meet the Navy's global demands.[14] Among other inputs, classified campaign analyses done in 1999-2001 showed that the programmed fleet lacked the capability to cope with enemy littoral activity in some projected combat scenarios.[15] This insight led the Navy staff to generate a report in early 2002 calling for small ships to provide the sorts of capabilities called for by *Streetfighter* advocates: anti-submarine warfare, mine warfare, and surface warfare against small boat threats.[16]

Two important developments in Washington steered the Navy towards developing a new class of small ship with such capabilities: in 2000 ADM Vern Clark became the CNO and in 2001 Donald Rumsfeld became the Secretary of Defense. When ADM Clark became

[13] Work, 63.
[14] The Navy had already restructured its science and technology (S&T) program to refocus on 12 technologies that it saw as important to the new era, littoral mine warfare and anti-submarine warfare among them.
[15] Interview with Charles Werchado and Web Ewell, OSD/PA&E, 8 November 2006.
[16] It is important to note, however, that while adherents to the idea of new investment in small ships grew in numbers within the Navy, they did not always identify their position with *Streetfighter*. The *Streetfighter* concept was popularly identified with some negative attributes— including a lack of endurance—that were not characteristics of all *Streetfighter*-type designs. Work, 67-68.

the CNO in July 2000, he ordered his staff to study the advantages and disadvantages of the *Streetfighter* concept.[17] This represented the first significant assessment of the merits of a new class of small ships by the surface Navy community. This interest in new ship types was coupled with a close examination of ships already programmed. Soon after Clark became CNO, Secretary of Defense Donald Rumsfeld made transforming the military an important priority. The 2001 Quadrennial Defense Review (QDR) entailed a review of every defense program. The DD-21 was foremost among the Navy programs whose transformation credentials were questioned. The DD-21 incorporated a broad array of advanced technologies, but it was large and expensive. Moreover, the main source of its firepower—the big guns on its deck—was reminiscent of the battleships that had only recently been retired from the fleet.

On November 1, 2001, one month after the QDR report was officially released, small combatants in the Navy made an important breakthrough. The DD-21 was to be replaced by a family of ships: the DD(X) (today called DDG-1000), the CG(X), and a small combatant, the LCS. A confluence of factors led to this action. The DD-21 was targeted by OSD for elimination due in part to its high cost and in part to a judgment that it was not sufficiently transformational to cope with the emerging security environment. Separately, the Navy, with CNO Clark's strong advocacy, wanted to add a small ship. A new class of small ship would meet identified capabilities gaps and enable the Navy to meet its numerical force structure goals. As mentioned earlier in the context of the 1997 GAO report, it was widely recognized that the Navy could not afford a 375-ship composed of existing platform designs. The comparatively low-cost LCS was the only way to reach the desired end strength; it could be bought in large numbers and could perform the sorts of low-intensity peacetime missions that were taxing the existing fleet.[18]

The LCS Program

The LCS program quickly gathered steam. Analysis from OSD, a task force at the Naval War College, and the LCS Program Office (established in February 2002) contributed to developing the ship's basic attributes. Key points of debate included whether the ship should embark a helicopter, whether it needed to reach speeds of 50 knots, and whether it needed to be capable of self-deploying across the Pacific. A ship that had no helicopter and had no need of self-deploying could be quite small and reach speeds of over 50 knots. This description most closely matches early *Streetfighter* designs, although some *Streetfighter*-type proposals had included a helicopter and left questions of endurance to future designers. A self-deploying, helicopter-carrying ship would have to be larger and slower.

Analysis in N-81 and in OSD's Office of Program Analysis and Evaluation (PA&E) strongly supported a self-deploying ship that, primarily for ASW and MIW purposes,

[17] Work, 64.

[18] The Navy was later criticized for not doing enough analysis on the need for a new class of ship for littoral operations. The Navy reexamined this question in 2004 and found that in fact the LCS, rather than new operating concepts for existing platforms, was best suited for the required littoral missions.

embarked a helicopter.[19] This was later echoed by a study team at the Naval War College. The Navy's Surface Warfare (Requirements) Directorate (N76) tasked the Naval War College to study what the LCS should be able to do and what technologies it should incorporate. An LCS Task Force used a series of workshops to analyze these questions. The Task Force identified three primary missions and three secondary missions for LCS.[20] The primary missions matched the capability gaps identified by earlier Navy analysis:

1. Anti-submarine warfare
2. Mine warfare
3. Surface warfare (SUW) against small boats

The secondary missions were:

1. Maritime interdiction
2. Special operations forces (SOF) insertion and support
3. Tasks related to command, control, communications, computer, intelligence, surveillance, and reconnaissance (C4ISR)

The Task Force also recommended that the LCS mission be accomplished by three separate types of ships: a ship to speed into the littoral, deploy off-board (largely autonomous) sensors and weapons, and depart; a small combatant designed primarily to fight other small ships; and a larger, corvette-type ship that would have some of the capabilities of each of the other two. If only one type of LCS could be built, however, the Task Force recommended that it be the corvette. Through modularity, organic combat power, and use of unmanned systems, this corvette could cover the range of missions identified.

The Task Force also concluded that the LCS should carry a helicopter, particularly to enable ASW and MIW. The helicopter would also have to be organic, with a hanger to shelter it and diminish the ship's radar signature. This increased the required size of the ship.

The LCS Program Office and Naval Sea Systems Command (NAVSEA) also did their own analysis, dubbed "Analysis of Multiple Concepts" (AMC).[21] They considered five

[19] Interview with Charles Werchado and Web Ewell, OSD/PA&E, November 8, 2006.
[20] CDR Carl Carlson, Bradd C. Hayes, Hank Kamradt with Gregg Hoffman. "Littoral Combat Ship (LCS) Characteristics Task Force Final Report," July 31, 2002.
[21] This AMC was done in place of the Analysis of Alternatives (AoA) typically required of weapons procurement programs. Though OSD determined that the analysis done for the LCS was adequate, the program was faulted for not rigorously considering non-ship alternatives to the LCS missions and for completing the AMC well after the Navy released the initial request for proposals to industry. This approach created the sense that LCS analysis (or at least the formal AMC) was being done after the answer had been determined.

basic LCS alternatives, which were examined by the Naval Surface Warfare Center at Dahlgren from 2002 to 2004.[22] The five alternatives were:

- a small combatant with high speed but low endurance;
- a Coast Guard cutter;
- a larger combatant analogous to a frigate;
- a slightly smaller, self-deploying, modular advanced combatant; and
- a multi-purpose lift ship.

The AMC determined that the best alternative was the advanced combatant. In concurrence with OSD and NWDC analysis, the AMC concluded that this combatant would have some inherent self-defense capability but get the majority of its combat power from modules; embark a helicopter; have trans-oceanic endurance; and have an optimal speed of between 40 and 50 knots.

The LCS faced few programmatic hurdles. CNO Clark was a strong advocate of the ship, both within the Navy and with Congress, terming it his "number one budget priority."[23] His vision statement for the Navy, *Sea Power 21*, featured discussion of the littoral threat and of the LCS's role in defeating it.[24] In August 2002, less than a month after the NWC Task Force produced its final report, the Navy issued an initial request for proposals to industry to present LCS concepts. Six contracts were awarded for this concept work in November 2002. These proposals were downselected to three companies in July 2003 when Lockheed Martin, General Dynamics, and Raytheon were given contracts to develop detailed designs for the first LCS Flight. The Navy made the decision to initially procure more than one sea frame design and experiment with them before downselecting to a single prime contractor. In May 2004, both Lockheed and GD were awarded LCS contracts. They are building the LCS in shipyards (GD at Austal USA in Alabama; Lockheed at Marinette Marine in Wisconsin and Bollinger Shipyards in Texas and Louisiana) that have not recently built major Navy warships.

The Navy plans to procure 55 LCSs in flights. Flight 0 is being developed now, using ready or low-risk technology. The Navy decided in 2006 to extend Flight 0 from 4 ships to at least 15 ships, and also retain both Lockheed and GD as prime contractors through the 15th ship, which is due in FY2009.[25] Flight 1 is in development.

The LCS's three major missions will be those identified by the NWC Task Force: ASW, MIW, and SUW. LCS will also have the ability to perform what the requirements

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[22] *Analysis of Multiple Concepts – Littoral Combat Ship Study Phase III Report*, Naval Surface Warfare Center, Theater Warfare Systems Department, January 30, 2004.
[23] Scott C. Truver, "The Navy Plans to Develop the LCS with 'Lightening Speed," *Sea Power*, May 2003. Available online at <http://www.navyleague.org/sea_power/may_03_15.php>.
[24] Vern Clark, "Sea Power 21: Projecting Decisive Joint Capabilities," *Proceedings*, October 2002. Available online at <http://www.chinfo.navy.mil/navpalib/cno/proceedings.html>.
[25] Congress, however, has voiced concerns about the added cost of procuring two dissimilar designs. See Senate Report 109-254 – National Defense Authorization Act for Fiscal Year 2007. Available online at <http://thomas.loc.gov/cgi-bin/cpquery/?&dbname=cp109&sid=cp109njDpq&refer=&r_n=sr254.109&item=&sel=TOC_253717&>.

document terms “inherent missions”: joint logistics, SOF insertion and support, and ISR. It will further have the flexibility to carry out maritime interdiction operations (MIO). A forward deployed LCS will operate independently in limited scenarios (such as MIO or SOF support), with a squadron of other forward deployed LCSs to maintain a presence in important theaters in advance of hostilities, and with a carrier or expeditionary strike group in high threat environments. The ships will have a crew of around 75 personnel: 40 core crew and 35 to man the mission modules and helicopters.

The capabilities for accomplishing the three major missions will be largely modular. Lockheed and GD are building the LCS sea frames, which will be capable of a top speed of roughly 45 knots, displace roughly 3000 tons (one third the displacement of an *Arleigh Burke* class destroyer), have a range of around 3,500 miles (giving them trans-Pacific capability), and have a payload capacity of between 180 and 210 tons. The sea frames will use this payload capacity to accommodate a modular mission package, which will be built separately from the sea frame and installed on the ship in accordance with operational needs. There will be three types of mission packages for the Flight 0 LCSs, one each for ASW, MIW, and SUW. They will be swappable in 1–4 days. These mission modules make substantial use of both manned and unmanned off-board systems. The Navy plans to procure around 90 total modules, which Northrop Grumman was given a contract to integrate. Both GD’s and Lockheed’s designs can accommodate two MH-60 helicopters, which provide critical capability for MIW and ASW.

Though the LCS has progressed quickly from plans to ship (the first vessel, from Lockheed, should be complete in February 2007, less than six years after the program was first announced), issues remain to be resolved. The program is more expensive than anticipated. The Navy initially planned to spend $220M on each sea frame. The cost is now estimated to be $270M. The mission modules will cost an average of $150M per ship. Total system acquisition costs could come to more than $470M per ship.[26] Critics also point to possible operational shortcomings. The LCS will not, for instance, have substantial self-defense capability against other warships or aircraft, limiting its ability to operate alone in high-threat areas. Its small crew will have difficulty performing manpower-intensive MIO, and it will be difficult to accommodate the large number of men needed to support a helicopter detachment. Its reliance on slower offboard systems to perform its major missions will limit the utility of its high speed in some scenarios, like escort duty. Even if all works as planned, the Navy still faces the task of learning to operate a new class of ship, one whose small size, modularity, and minimal manning bring new challenges along with new capabilities.

[26] Ronald O’Rourke, “Navy Littoral Combat Ship (LCS): Background and Issues for Congress,” Congressional Research Service, April 19, 2006.

Question 1: How would the LCS be different if different decisions had been made on these five key points?

Helicopter. Making the LCS capable of supporting helicopters was an important driver of several ship characteristics. First and foremost, it made the ship bigger. A flight deck required both surface area and structural reinforcement, adding to size, weight, and cost. Further, the decision was made that a "lilypad" CONOPs (that is, the LCS would be configured to operate a helicopter only for brief stretches) was not sufficient for the LCS's mission needs: it would have to be able to embark and support a helicopter indefinitely. This meant that a hanger needed to be designed for the ship. This sheltered the helicopter from the elements and provided a lower radar signature than would a helicopter on the deck, but also took up more space.

The helicopter for the LCS also added to the ship's manning requirement. Of the 35 personnel not part of the core crew, 15 are supposed to man the embarked mission module while 20 are to support the helicopters and UAVs. That is fewer personnel than support helicopters on surface combatants today, and both the lower numbers and the concept of tasking these personnel to handle both the helicopters and the UAVs is resisted by the naval aviation community.

Without a helicopter, however, the LCS would have had to look for different options to perform its core missions, particularly ASW and MIW.

Mothership. One innovative idea for a new class of small ships was to make use of a mothership, from which small combatants would sortie, just as aircraft sortie from aircraft carriers. By adopting such a concept, which was proposed by Hughes and others, the Navy would have been able to build smaller, individually less expensive ships for use in the littoral. Because these ships did not have to self-deploy or sustain themselves for long periods, naval architects could have designed increased speed and payload fraction in place of the endurance needed for transoceanic deployment but *not* needed for tactical mission execution. Their low cost, low manning, and higher numbers would have made such combatants less costly to lose in combat.

The LCS was instead designed to self-deploy and, in some cases, operate independently of other ships. This meant it had to be large enough to carry the fuel and supplies necessary to transit the Pacific while still having a useful payload. Its size is one factor in its higher cost and lower planned numbers compared to the sort of hypothetical littoral ships that would operate from a mothership.

Modularity. The LCS derives the capability it needs to perform its major missions from modular mission packages. While modularity was a long-standing feature of the notional small ships featured in the debates preceding the LCS program, a small ship could have been built without it. Indeed, in keeping with the initial *Streetfighter* concept of a family

of small ships, the fleet could have been provided with a range of littoral capabilities by making different members of that family tailored to different missions. Tailored ships would present fewer logistical challenges. Tailored ships would also have a lower up-front unit cost, with no need to invest in multifunctional interfaces and no need to buy more than one tailored combat suite per ship. Though the Navy must find a way to make the LCS's modules and the specialized crews to man them readily accessible to the theater of operations, the ship offers the promise of being able to change the fleet's capabilities mix to meet the Navy's immediate needs. In the long term, the Navy can hope that the LCS will realize cost savings compared to a tailored littoral alternative, as the ship's modularity makes it comparatively easy to upgrade existing systems or add entirely new ones, thus providing an inherent hedge against obsolescence.

One LCS or Several? The initial *Streetfighter* concept called for a family of small ships, and as late as the NWC LCS Task Force workshops in 2002, there were advocates for building more than one kind of littoral craft. These advocates saw littoral missions that were best performed by several *types* of craft (as distinct from the Lockheed and GD *designs*, which, while different, are built to identical mission requirements) rather than one jack-of-all-trades LCS. Alternative small ship designs included both those intended to employ land attack and anti-ship missiles, a ship to fight other small surface craft, a small aviation ship, a ship designed primarily to deploy unattended, off-board systems, and a corvette-size ship like the LCS. Though the LCS's modularity gives it the flexibility to attend to a range of missions, any of these ships would arguably be better optimized for a specific littoral mission than the LCS. A sensor-deploying ship, for instance, could contribute more battlespace awareness than the LCS. It would also be less able to perform other missions, like countering small ships. Ships designed to perform one mission well (including those with some modular capabilities but fewer inherent capabilities than the LCS) could also be more austere and could be procured for a lower unit cost than a ship designed to perform several missions. Such low-cost,[27] single-mission ships could be acquired in greater numbers and would fit more neatly with the initial *Streetfighter* concept, which called for ships that could be treated as expendable. Such ships would also likely be less capable of operating independently than the LCS, and might have less range, limiting their usefulness in some scenarios.

Strike, Air Defense, and Anti-Ship Capability. To keep the LCS relatively low cost, the Navy could not give it the full spectrum of capabilities of other multimission surface combatants. Most notably, the LCS does not have significant strike capability, air defense capability, or capability to counter large surface ships. In omitting robust capability in these areas, the Navy made important decisions on the cost of these capabilities versus their value. The perceived value was based on the environment in which the Navy envisioned the LCS operating, the degree to which the current fleet could provide the capabilities in question, and the concept of operations intended for the ship. Consequently, the LCS concept of operations calls for the ship to operate with the rest of the battle fleet in many scenarios, particularly in high threat environments, rather than independently.

[27] Note that the over-all cost to the Navy of several distinct procurement programs could be higher than the LCS alternative.

Question 2. Is the LCS a Transformational Platform? Does it Transform the Fleet Structure?

The LCS as a platform has least one potentially transformational attribute: its modularity. Modular mission packages give the ship an operational flexibility not found in previous surface combatants. Modularity also means new technologies can be added to the LCS faster and at lower cost than if its capabilities were fully integrated.

The LCS could also have a transformative impact on the fleet across the spectrum of naval operations. In combat and pre-hostility scenarios, the LCS plays an important role in distributing the fleet's combat power and sensors. Through the larger numbers of ships and the unmanned vehicles they employ, LCSs will make the fleet's combat power more survivable and the fleet as a whole more tactically stable, enabling it to defeat A2/AD threats with reduced risk. Greater numbers of smaller platforms will present enemies with a more complex ISR and targeting challenge. More ships spread over a greater area, each distributing sensors through the use of unmanned vehicles, will provide enhanced battlespace knowledge.

The LCS could also have a transformative effect in operations short of combat. By adding greater numbers of ships to the fleet that are capable of self-deploying and operating independently, the Navy can improve its operational efficiency. The LCS will free high-end, multimission combatants from performing such tasks as MIO (to guard sea lines of communication or support sanctions), humanitarian assistance, and non-combatant evacuations.

Question 3. How is the LCS Similar to the Streetfighter Concept? How is it Different?

The LCS has most of the same key attributes as the *Streetfighter* concept: it is a small, fast, networked, and modular surface combatant that will make significant use of unmanned vehicles. There are significant differences in the degree to which it possess these attributes. The LCS is larger and slower than the speed posited by some *Streetfighter* concepts. This was driven in part by a decision to prioritize self-deployment and an organic helicopter for LCS, capabilities not found in most mooted *Streetfighter*-type designs.

The one of the primary differences between LCS and *Streetfighter* is a contentious one: its expendability. The initial *Streetfighter* concept, as outlined by Cebrowski and Hughes in 1999, called for a ship that was small enough and present in large enough numbers that the Navy could readily risk them in hazardous littoral waters without fear of losing a significant amount of combat power. Many took issue both with the idea that any ship should be considered expendable and the idea that the Navy was unwilling to risk the ships it already had. Regardless, the LCS was certainly not built with the explicit aim that it be expendable. Its cost (estimated at over $450 million) and numbers (planned procurement of 55 ships) suggest that the Navy does not plan on losing large numbers of them. Further, its CONOPS call for it to operate under the protection of the rest of the fleet in most threatening situations.